The following extracts from reports of cooperative observers are interesting:

Princeton: The storm cloud looked like a ball of black smoke.

Staves: There were two storm clouds, one at 6 p. m. and another about thirty minutes later, both moving in the same direction. The first did the greater damage.

England, Lonoke County: I watched the clouds for about an hour before the storm reached England, as I had read the Weather Bureau map at 5 p. m., and was expecting a severe storm. I did not see any funnel-shaped cloud, but that may have been due to the fact that the clouds were low and it was rather dark. About ten minutes before the storm there was much lightning in the west, southwest, and south, and the clouds were going north. At about the same time the clouds changed to northeast, and ten minutes later had passed away. The high wind did not last more than two or three minutes. While the wind was blowing the roar was like that made by many freight cars going at a great speed. Large trees were uprooted and carried a great distance away, the trees in the storm's path having been twisted off about 10 or 15 feet above the ground.—Dr. J. C. Chenault.

Brinkley: The tornado struck this place about 7:10 p. m., central time, and crossed the city from southwest to northeast. It was preceded by vivid lightning and a hard rain, and did not last more than five minutes. The path of greatest destruction extended from a point about 5 miles southwest to a point about 10 miles northeast of the town. About 260 residences and 600 other buildings were totally destroyed, and 750 dwellings and 1,200 other buildings were partially destroyed. The total losses amounted to $600,000, of which five-sixths were in buildings. Many buildings rocked preceptibly before crashing to the ground. The destruction of the electric-lighting plant threw the city into darkness. Fires started at many points, and only the heavy downpour of rain that followed prevented a general conflagration. In several instances all the members of a family were killed. A number of cars were blown from the tracks of the Rock Island Railroad at Brinkley and Kerr.

April, 1909.

Tornadoes occurred in Monroe and Woodruff counties on the 6th. One person was injured, and the losses in buildings and merchandise were about $5,000.

On the 29th tornadoes occurred in nine northern and three southern counties, killing 17 people, injuring 76 others, and causing property destruction aggregating about $100,000.—*H. F. Alciatore.*

RED SNOW IN MICHIGAN.

By A. WIESNER. Dated: Houghton, Mich., April 13, 1909.

Late Saturday night or early Sunday morning Calumet was visited by a peculiar storm in that from the air fell a reddish brown sand, mixed with snow, the storm lasting probably the greater part of a half hour. The wind as near as could be judged because of its irregular velocity and variations came from an easterly to southeasterly direction. The sand was fine and light. It has been learned that this sand fell Saturday night and Sunday morning all over the upper peninsula. As far as can be learned no one has advanced an explanation of the phenomenon.

Explorers in the Arctic regions have told of falls of "red" snow similar[1] to that which visited Calumet Saturday night. Often at sea ships are covered with a like substance, which falls from the heavens, although the ship be many miles from land. It is supposed the high wind carried the sand a great distance from some point where the earth was bare of snow and was dry.

With reference to the above extract from the Mining Gazette of Houghton, Mich., for April 13, 1909, I would add that this phenomenon was particularly noticeable at Lake Linden and Calumet, 10 to 12 miles north of Houghton. Fine traces of this dust, resembling powdered brick or hematite dust, were also noticeable in Houghton on the station psychrometer and on the upper surface of the thermograph. The wind during the night of this occurrence, April 10–11, 1909, was brisk east to southeast, the weather was damp, and most of the ground in this locality was still covered with snow. It is evident, therefore, that the dust was not of local origin.

[1] The "red snow" of the polar regions usually owes its color to the rapid increase of a microscopic red fungus-like plant, and rarely to a mineral coloring matter, as in the present case. See Monthly Weather Review, 1901, 29; 465, and elsewhere.—*C. A., jr.*

THE AURORA OF MAY 15-16, 1909.

The captain of the Hamburg-American steamer *Pallanza* sends the following very interesting report to the Marine Division of the Weather Bureau.

[TRANSLATION.]

NEW YORK, N. Y., *May 17, 1909.*

To the DEUTSCHE SEEWARTE,
HAMBURG, GERMANY.

On the night of May 14–15, 1909, as the steamship *Pallanza*, en route to New York, was in longitude 62° to 64° west, a bright aurora was observed.

The next night, May 15–16, as we were nearing the Nantucket Shoals lightship another and very singular display was observed. The night was calm and very clear, the stars visible almost to the horizon, when from about 10 p. m. to midnight I observed two brilliant spots of pure white light in the northwest and northeast, respectively. These spots had the outline of a candle flame and their intensity varied from that of mild moonlight to a light so strong that it was almost possible to read by it on the bridge. In the brighter intervals fascicles of rays shot from each spot to the zenith, where, from time to time both spots were united in a great arc of light intersecting the Milky Way at an angle of 20°. Stars of the higher magnitudes were distinctly recognizable through the aurora itself.

Both spots appeared to have sharply defined bases at an altitude of about 40°, sending vertical streamers toward the zenith only. No luminous phenomena were visible from the bases of the brilliant spots down to the horizon. At the same time very frequent heat lightning was observed in the west.

At 2:45 a. m. we passed the Nantucket Shoals lightship at a speed of 11 miles per hour. In the mean time—about 1 a. m.—the aurora in the northwest had disappeared and the one in the northeast had shifted slowly to about due east, where it remained visible until daybreak. The heat lightning in the west had continued uninterruptedly.

At 7:20 a. m., May 16, the ship ran into a bank of fog, whereupon the compass immediately began to oscillate and show perceptible electrical disturbances. Repeated observations showed a sudden increase in the easterly deviation amounting to about 1.5°. Accurate determinations of this increase were not practicable on account of the oscillations of the compass card, which swung 15° to 22° to either side. When the fog disappeared about 10 a. m. this magnetic disturbance disappeared also.

I believe I am not in error when I assume a causal connection between the above described phenomena.

Very respectfully,

(Signed) R. NISS, *Captain.*

We reprint the following observation[1] of the same aurora as seen from Blue Hill Observatory, Mass., in latitude 42° 13′ N., longitude 71° 07′ W., altitude 105 meters.

BLUE HILL OBSERVATORY, *May 17, 1909.*

One of the brightest auroras seen in recent years at Blue Hill Observatory was visible for several hours on the evening of May 15 last. When first observed, at 8:58 p. m., it formed three detached luminous patches, the two brightest having been near the zenith. At 9:10 p. m. the latter two merged to form one large bluish-gray mass, of unusual brightness. After that, the luminosity changed rapidly from moment to moment, while the form was altered but slightly, the whole mass moving slowly to the south and west. For about three quarters of an hour the main mass took the shape of a long-handled dipper, the bowl appearing like the head, and the handle like the tail of a huge comet, which many people thought the phenomenon to be. At 10:36 p. m. it was seen as five detached areas of light, which, after about ten minutes, joined to form an unbroken arch which reached from west to east almost entirely across the sky, the highest point passing slightly to the south of the zenith. After 11 o'clock the arch broke up into separate masses which changed in brilliancy from time to time, but gradually faded until all had disappeared by 11:30 p. m. In the two hours from 8:59 p. m. to 10.59 p. m. the mass moved as a whole about 25° toward the south and about 50° toward the west, as measured from a point near the center of the main mass which was originally about 5° to the north of the zenith. After 10 o'clock we had the unusual condition of the "northern lights" entirely to the south of a west-to-east line through the zenith. It is also worthy of note that the southern border was at all times a distinct and clean-cut line, while the northern border was everywhere indefinite, gradually dying out at about 30° to the north of the zenith. During the course of the evening the luminous area varied in width from 10° to about 35°.

The aurora was remarkable on account of its unusual position, its rapid changes in brilliancy, and its varying shape. The color was a pale bluish-gray, no iridescence having been seen at any time. Moreover, there was no suggestion of streamers or rapidly-moving iridescent patches, often referred to as "merry dancers." When the aurora was

[1] See Science, 1909, 30 (N.S.):57.

at its maximum brilliancy only the stars of brightest magnitude could be seen in that region of the sky, and the "milky way" was rendered entirely invisible. Over nine-tenths of the sky was cloudless throughout the evening, a trace of alto-stratus having been visible above the northern horizon, and an equal amount of cumulo-nimbus with distant lightning having been seen far off to the west. ANDREW H. PALMER.

Captain Niss in his description remarks that at 7:20 a. m. of May 16 his ship ran into a bank of fog and that coincidently his compass began to oscillate, swinging 15° to 22° to either side of an easterly deviation which was 1.5° greater than that normal for the year and place. This oscillation and increased deviation both ceased when he ran out of the fog, and his last sentence might give the impression that he ascribes the compass disturbance to the presence of the fog, but this is not at all likely.

One may, however, explain this sudden compass deviation in two ways. (1) It may have been the expression of the highly charged lower atmospheric strata which must have accompanied the well-marked thunderstorms to the west reported by both observers. In this case the needle disturbances would have been characteristically sharp jumps from the normal position, occurring at the times of the discharges. (2) It may have been due to the continued auroral phenomena, become invisible in the light of dawn. In this case the needle would have oscillated more or less strongly swinging to either side of the normal deviation, if there were such vibrations as produce the the "merry dancers"; or would have remained more steady, perhaps at an abnormal point if the aurora were in the nature of a glow. Captain Niss' report is not quite explicit enough to permit us to choose between these explanations.—*C. A., jr.*

AN ANNOTATED BIBLIOGRAPHY OF EVAPORATION.

By MRS. GRACE J. LIVINGSTON. Dated Washington, D. C., January 8, 1908.

[*Continued from the Monthly Weather Review, March, 1909.*]

1889—*Continued.*

Grossmann. [L.]
Beiträge zur Geschichte und Theorie des Psychrometers. Met. Zeits., 1889, 6:121-30, 164-76.

Discusses the history and theory of the psychrometer.

Seyfert, T.
Der Einfluss des Bedeckens und des Mischens der Moorboden mit Sand auf seine Verdunstungs- und Temperaturverhältnisse. Mitt. z. Förderung der Moorkultur, 1889, Nos. 17, 18: 205-23; Centbl. Agr. Chem., 1889, (—):678-80. Abstract in Forsch. Geb. Agr. Phys., 1880, 13:63-4.

Experiments in evaporation from natural moor soil, from the same with sand mixed into the surface layer, and from the same with sand on top but not mixed in, for the period June to October, gave amounts in the proportion, 100:38:20. The effect of a surface layer of sand in retarding evaporation is clearly shown.

Symon, G. J.
On the amount of evaporation. Brit. rainf., 1889, (—):18-43.

A complete résumé of all previous reports of evaporation published in "British Rainfall" from 1867 to 1887, together with descriptions and drawings of the various instruments used at Strathfield Turgiss. Tables of daily evaporation at Camden Square from July, 1889 to June, 1890, and the totals and maxima for each month and year from 1885-1890 are given.

Tacchini, P.
Temperatura ed evaporazione a Massaua. Atti r. accad. Lincei, 1889, 5 (4):329-30.

Investigations show that evaporation at Massaua is almost twice that at places whose mean temperatures are but half as high.

Place.	Mean annual temperature.	Mean daily evaporation.
	°C.	Mm.
Bari	15.7	3.1
Massaua	29.8	7.3
Reggio (Calabria)	17.6	3.6

Voeikov.
See Woeikof.

Waldo, Frank.
Distribution of wind velocities in the United States. Amer. met. jour., 1889, 6:309-10.

Discusses the relation between the distribution of wind velocities and evaporation. Describes Russell's (1886, 1888) experiments in this line.

Woeikof, Alexander.
Der Einfluss einer Schneedecke auf Boden, Klima, und Wetter. Geog. Abh., 1889, 3 (Hft. 3):99.

Although the air above a large extent of snow is usually saturated owing to the continual evaporation from the snow, certain winds are so dry that the evaporation can not always maintain this saturated condition of the air. A greater dryness in the air above snow may also result in decreased evaporation due to the lower temperature of the snow compared that of the air.

1890.

Abbe, Cleveland.
Preparatory studies for deductive methods in storm and weather predictions. Ann. Rpt. Chief Signal Officer for 1889. Washington. 1890. App. 15, p. 117-21.

Discusses the various factors influencing the rate of evaporation. For meteorological purposes evaporation from a free water surface, or preferably from moistened cloth or paper, as in the ordinary psychrometer or in the Piche atmometer, is considered a sufficient indication of the evaporating power of the air. Presents the conclusions reached by Tate; the formulas derived by Wellenmann, Stelling, and Fitzgerald; and Russell's comparisons of evaporation with changes in wind velocity.

Battelli, Angelo.
Sull' evaporation dell' acqua e del terreno umido. Nuovo cimento, 1890, 28(3):247-56. Abstract in Naturw. Runds., 1891, 6:270; Ann. uffic. cent. met. Ital., 9:—; Met. Zeits., 1891, 8:394.

Comparative measurements of evaporation, both in sun and shade, from a free water surface and from soil saturated with water, at Chieri (Turin). Also observed a Piche atmometer, a psychrometer, and an anemometer. (See Battelli, 1892.)

Brückner, Eduard.
Verdunstung einer Schneedecke. Met. Zeits., 1890, 7:150-2.

Review of Voeikov, 1889 and 1890. According to Brückner condensation ordinarily occurs on snow, rather than evaporation from it.

Colin, R. P. E.
Observations météorologiques faites à Tananarive. Obs. roy. de Madagascar. Tananarive. 1890. 2 vols. 8vo. Review in Symons's met. mag., 1892, 27:38-40.

His evaporator consists of a zinc tank, 40×40×2.5 inches, inclosed in a wooden box. A table gives the evaporation for the first ten days in February, 1890.

Ekholm, Nils.
Zur Frage über die Verdunstung einer Schneelage. Met. Zeits., 1890, 7:224-6. Notice in Forsch. Geb. Agr. Phys., 1890, 13:475.

Discusses the question raised by Voeikov (1890), who declared that snow will evaporate when the temperature of the air is below zero.

Houdaille, F.
Mesure de l'évaporation diurne; description d'un évaporomètre enregistreur. Bul. mét. Hérault, 1890. See Houdaille, 1892.

Conclusions: (1) Daily evaporation as measured by the Piche atmometer is very irregular as compared with that from an evaporating surface more naturally exposed to the action of the wind and nearer the temperature of the air. (2) A continuous record of the rate of evaporation is important for meteorology and for various industries. (3) Describes a recording "evaporometer," which employs the registering mechanism of the Richard thermograph. (4) This rate is always much higher in the daytime than at night, generally at least three times higher. (5) The maxima are determined by the predominance of one of the three factors, temperature, relative humidity, and wind velocity.

Specifies objections to the Piche atmometer. Describes his own atmometer, which consists of an evaporating surface of blotting paper clamped on a brass plate connected with a graduated Mariotte's tube. An opening, 2 mm. in diameter, in the brass plate allows the liquid supplied from the tube to keep the paper constantly soaked.

Moulan, T.-C.
Quantités d'eau évaporées ou absorbées par la végétation dans la bassin de la Gileppe. Ciel et terre, 1890, 11:328.

Approximate estimate of the water absorbed or evaporated by vegetation.

Russell, Thomas.
Evaporation. Mo. Weather Rev., 1890, 18:290.

Table 1 shows the depth of monthly evaporation for 1888-9, as measured in a pan and by a Piche atmometer, at Sweetwater Dam, San Diego County, Cal. Table 2 shows the depths of evaporation observed at a number of stations in 1888-90 with Piche atmometers. Tables 3 and 4 show the depths evaporated from pans at stations other than those where the Piche had been used.

Symons, G. J.
On the amount of evaporation. Brit. rainf., 1890, (—):17-31.

Deals in detail with the work of Dines, 1870; Evans at Nash Mills, Hertfordshire (see Greaves, 1876); Greaves, 1876; Lawes at Rothamsted; S. H. Miller at Wisbech, 1878; Peek at Rousdon Observatory, near Lyme Regis, Devon; and Russell at Sydney, N. S. W. Symons assumes that at Sydney a facsimile of the Strathfield Turgiss tanks would lose about 30 inches a year.

van Bebber, W. J.
Lehrbuch der Meteorologie. Stuttgart. 1890. p. 103-9.

General discussion of the process of evaporation, with a description of the Piche atmometer. Results of Eser, Ebermayer, and Stelling are reviewed.

Woeikof, A.
Verdunstung einer Schneelage. Met. Zeits., 1890, 7:38-9.

Points out that evaporation will take place from the surface of snow as long as the air temperature is below zero. (See Brückner, 1890.)

Wollny, E.
Forstlich-meteorologische Beobachtungen. (Zweite Mitteilung.) Forsch. Geb. Agr. Phys., 1890, 13:134-84.

Continued from 1887. (See Wollny, 1895, for summary.)

1891.

Allen, H. N.
See Brace, de W. B., and H. N. Allen.